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Bishop

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(54) **SINGLE ELEMENT WIRE TO BOARD CONNECTOR**

(2013.01); *H05K 2201/10287* (2013.01); *H05K 2201/10333* (2013.01); *H05K 2201/10962* (2013.01)

(71) Applicant: **AVX Corporation**, Fountain Inn, SC (US)

(58) **Field of Classification Search**

CPC H01R 4/4818

See application file for complete search history.

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(73) Assignee: **AVX CORPORATION**, Fountain Inn, SC (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/844,160**

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(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 14/312,505, filed on Jun. 23, 2014, now Pat. No. 9,136,641, which is a continuation of application No. 13/927,231, filed on Jun. 26, 2013, now abandoned, which is a continuation-in-part of application No. 13/666,427, filed on Nov. 1, 2012, now Pat. No. 8,721,376.

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(51) **Int. Cl.**

H01R 4/24 (2006.01)

H01R 4/48 (2006.01)

H01R 12/53 (2011.01)

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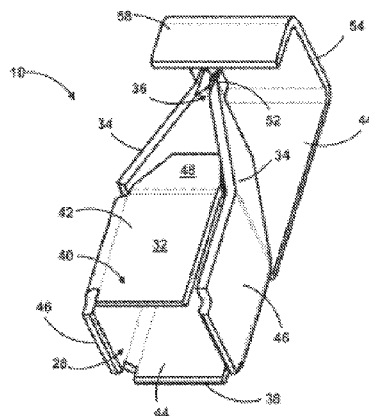
(57) **ABSTRACT**

A single element electrical connector includes a single conductive contact element formed into a cage structure having a wire insert end and a wire contact end along a longitudinal centerline axis of the connector. The cage structure defines an upper pick-up surface having a surface area suitable for placement of a suction nozzle of a vacuum transfer device, as well as a pair of contact tines biased towards the centerline axis to define a contact pinch point for an exposed core of a wire inserted into the connector. A contact surface is defined by a member of the cage structure for electrical mating contact with a respective contact element on a component on which the connector is mounted.

(52) **U.S. Cl.**

CPC **H01R 4/2404** (2013.01); **H01R 4/183** (2013.01); **H01R 4/4836** (2013.01); **H01R 12/53** (2013.01); **H01R 12/70** (2013.01); **H01R 12/7076** (2013.01); **H01R 13/62** (2013.01); **H05K 3/325** (2013.01); **H01R 12/718** (2013.01); **H01R 2101/00** (2013.01); **H05K 3/3421** (2013.01); **H05K 2201/09072**

20 Claims, 11 Drawing Sheets



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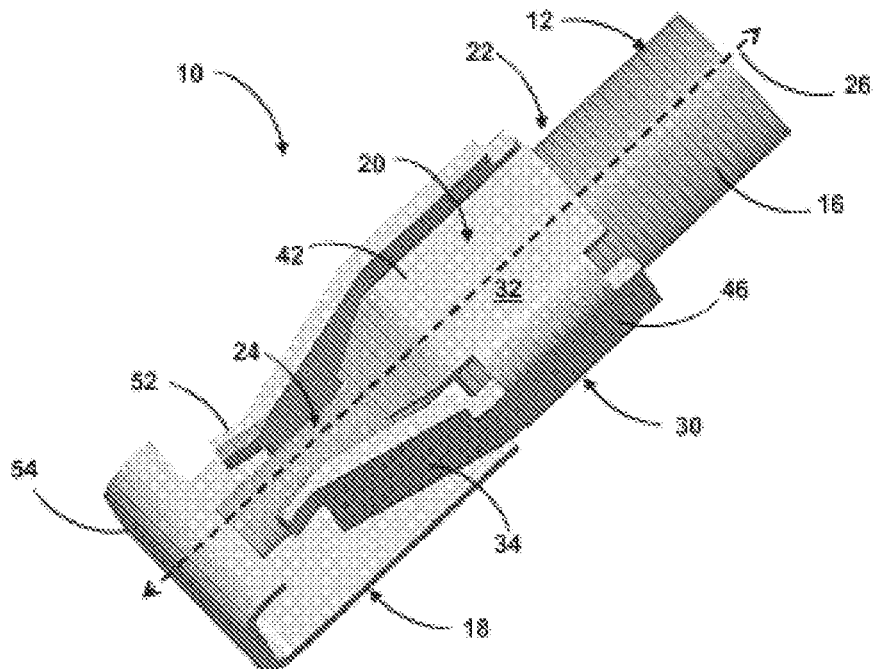


Fig. 1

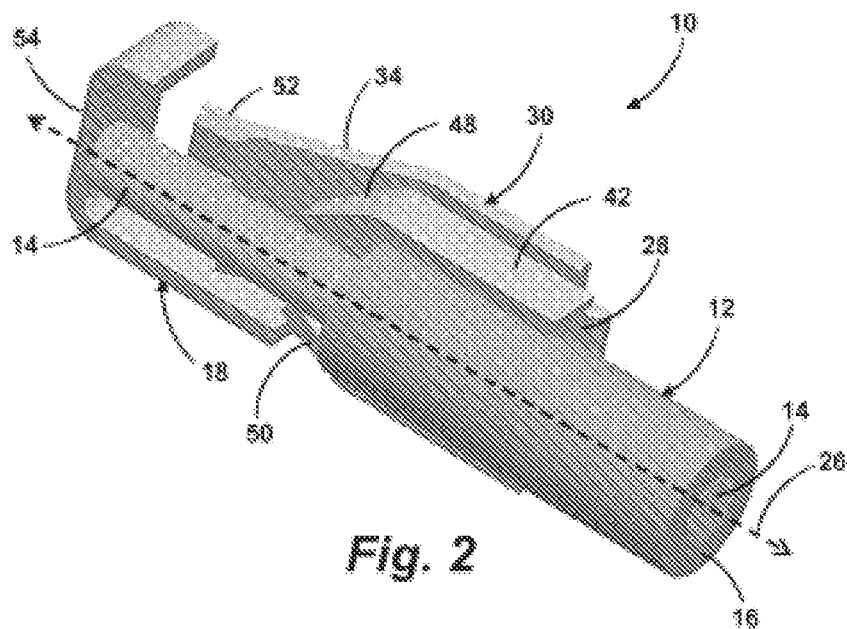


Fig. 2

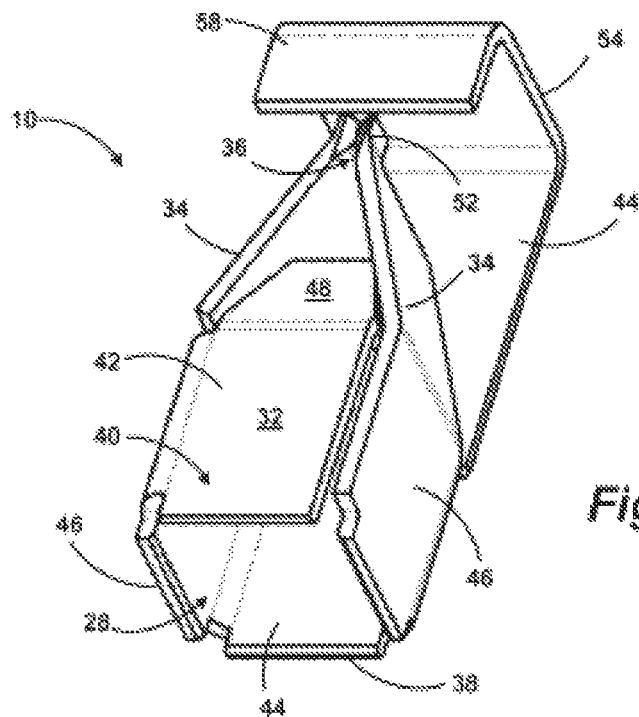


Fig. 3

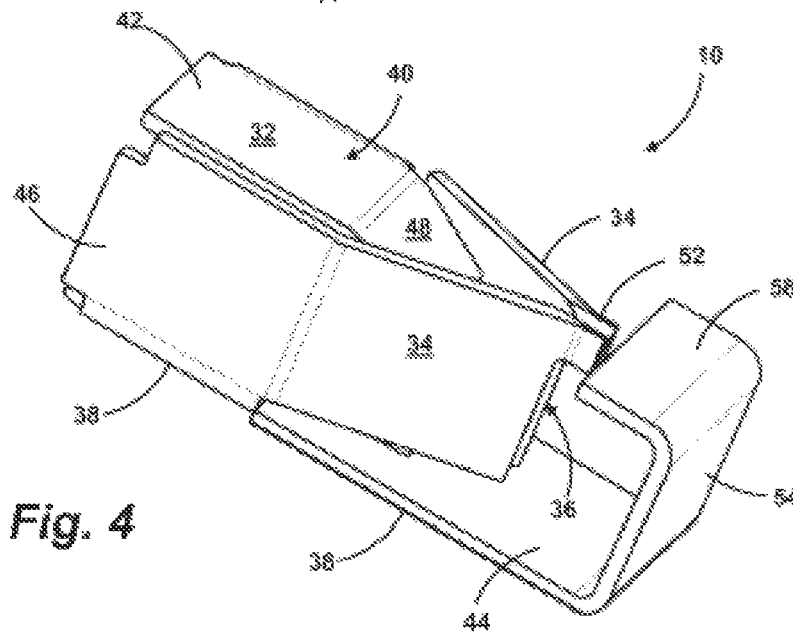


Fig. 4

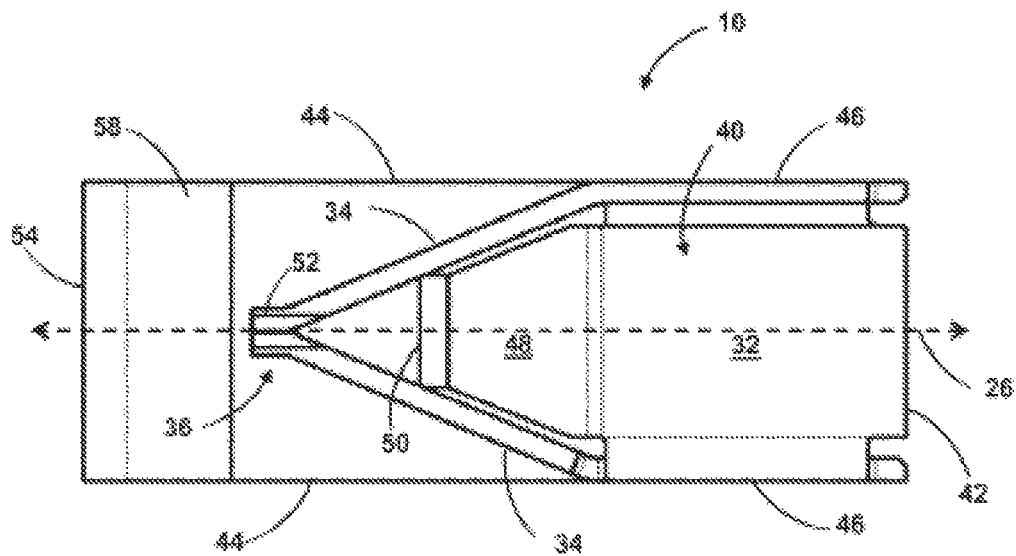


Fig. 5

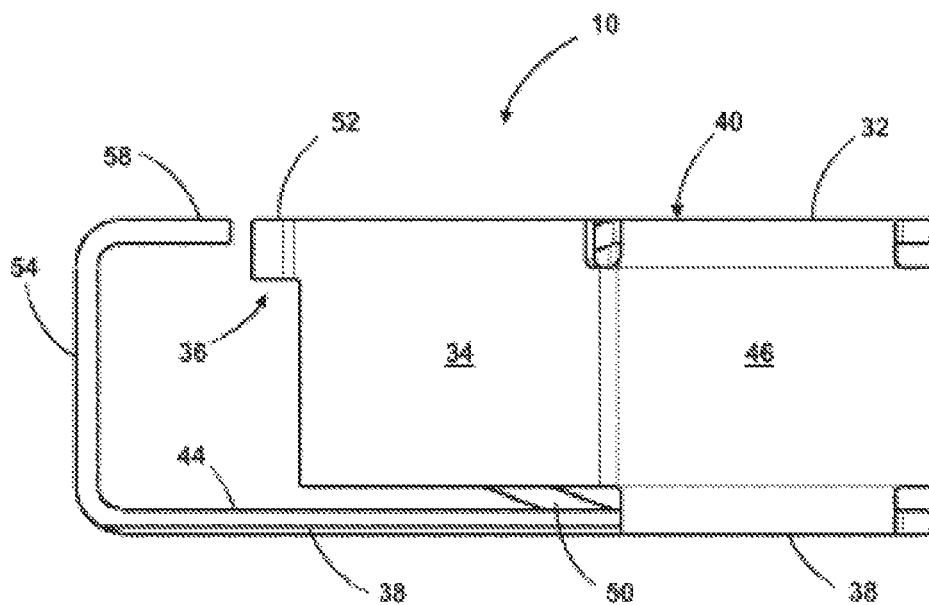


Fig. 6

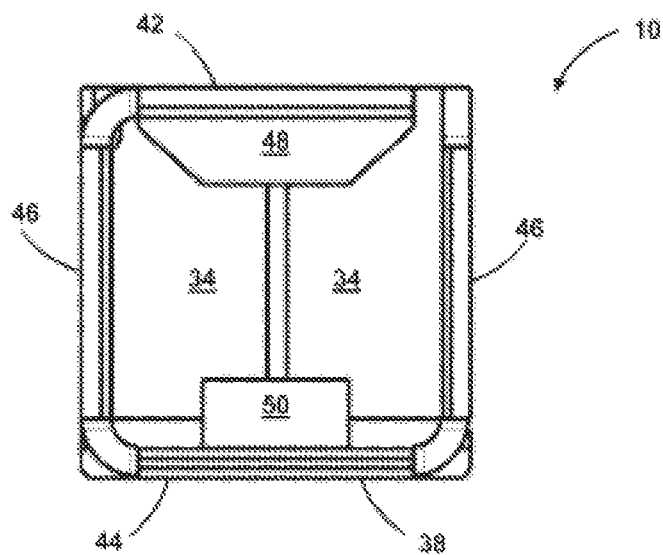


Fig. 7

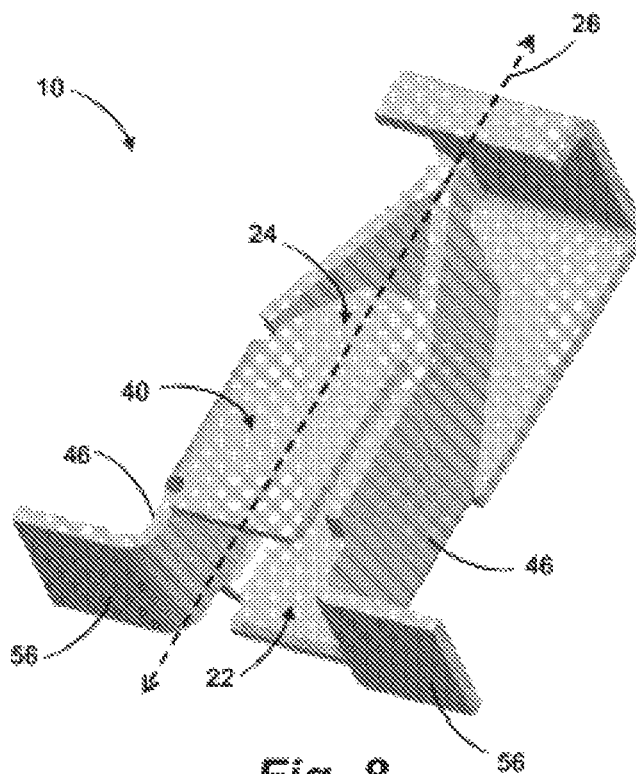


Fig. 8

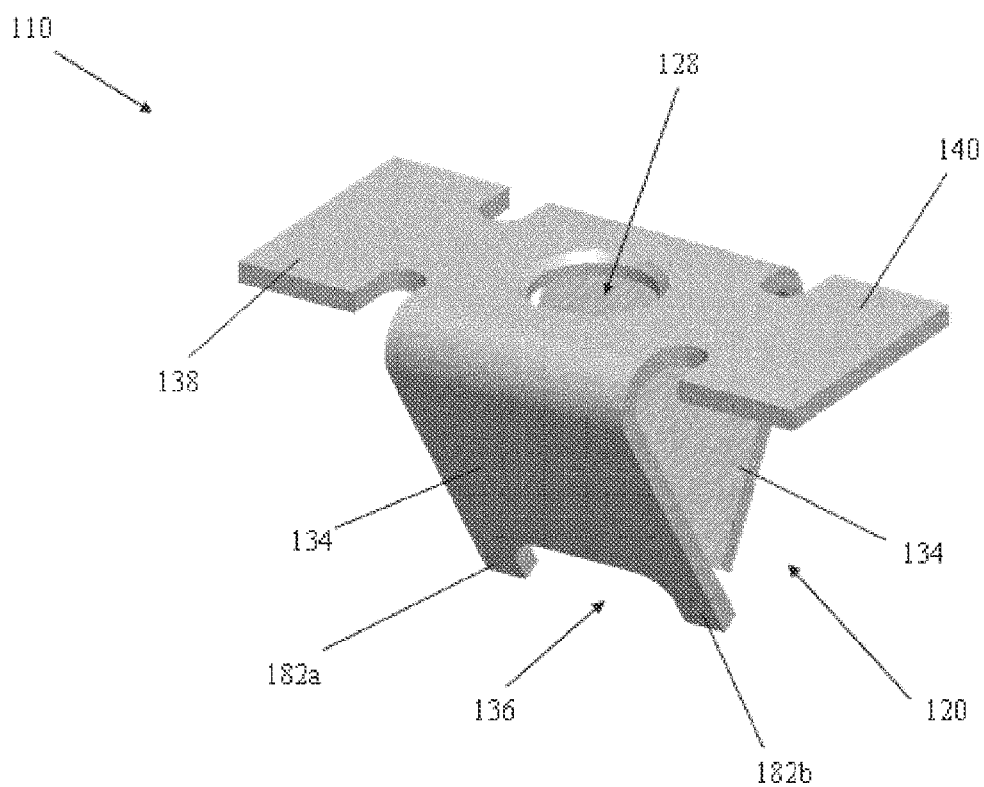


Fig. 9

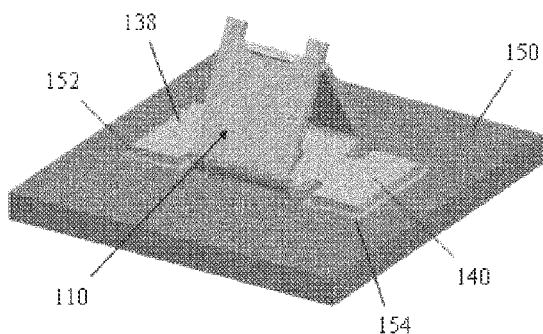


Fig. 10a

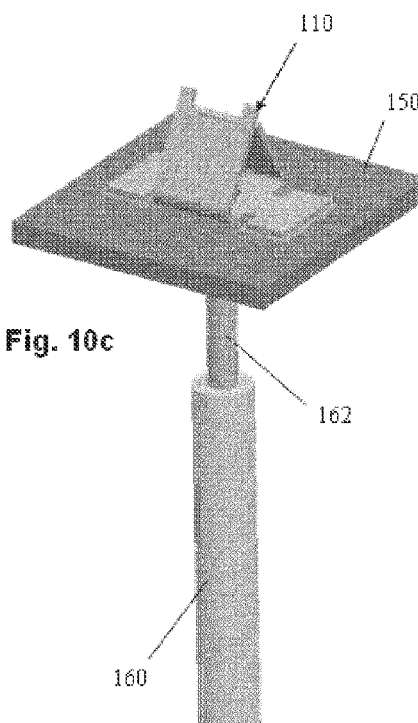


Fig. 10c

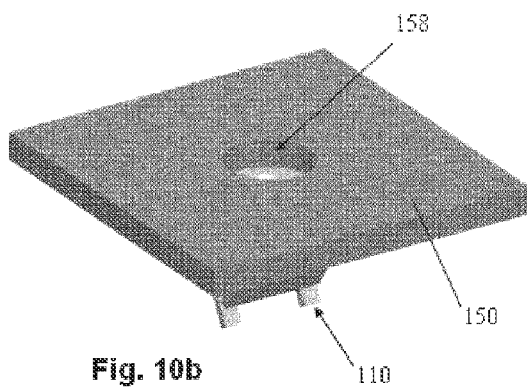
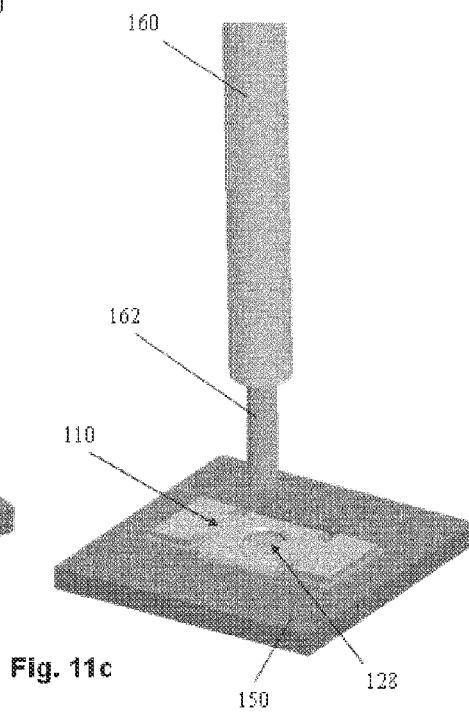
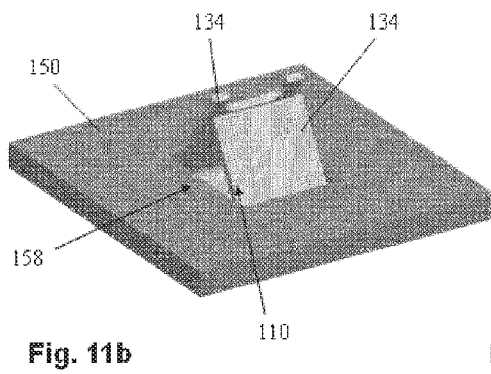
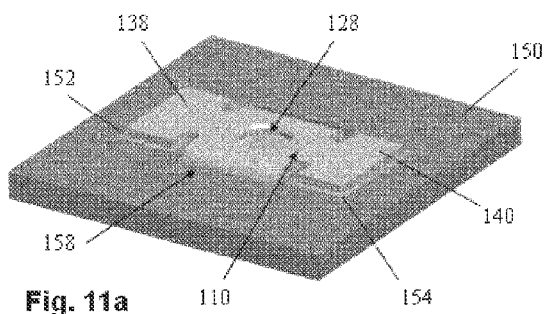


Fig. 10b



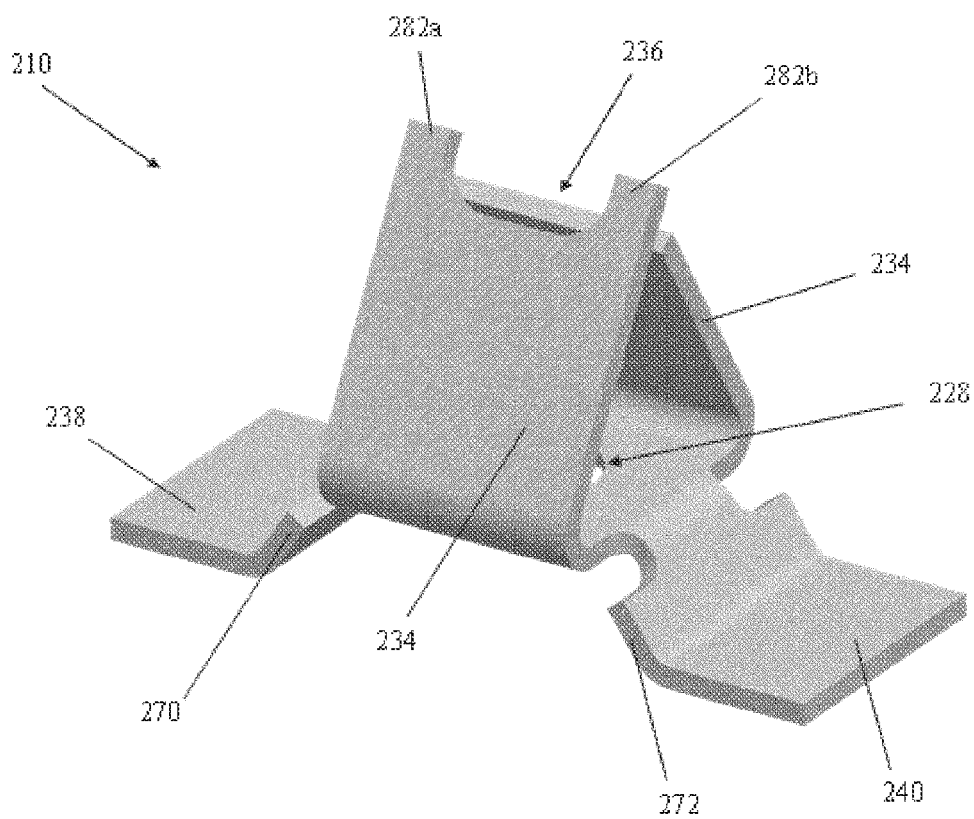
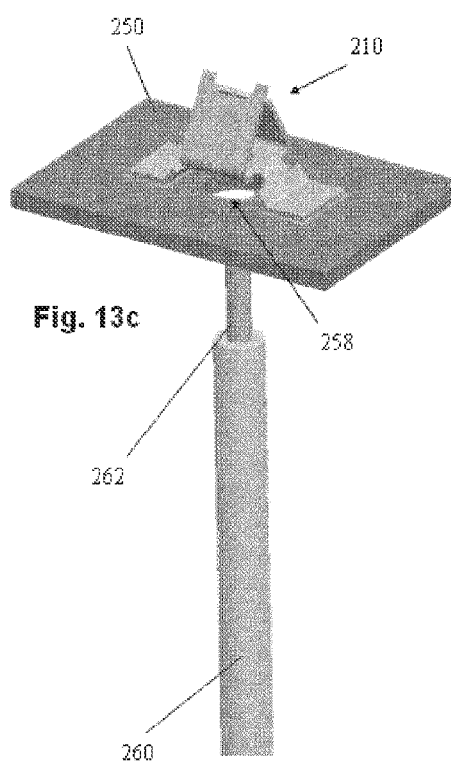
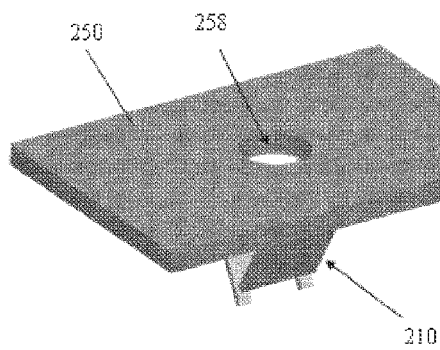
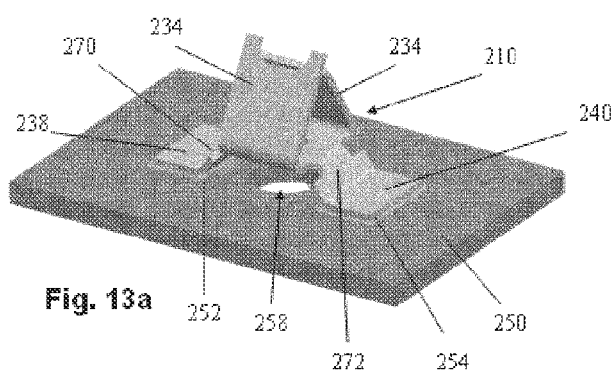


Fig. 12



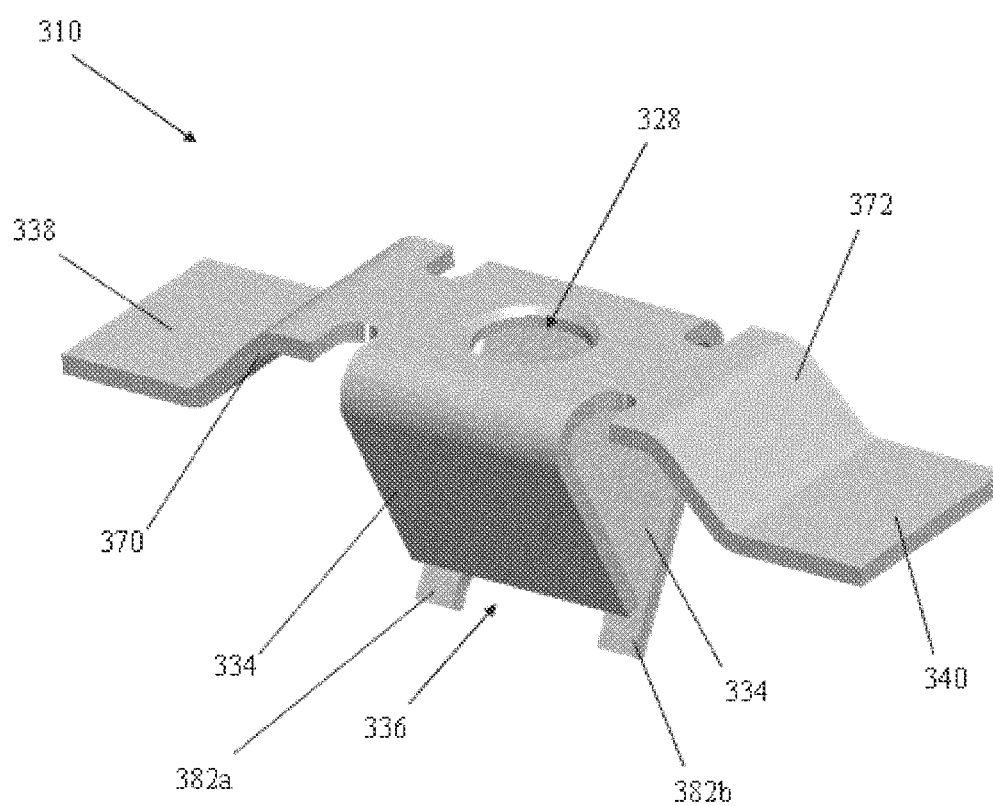
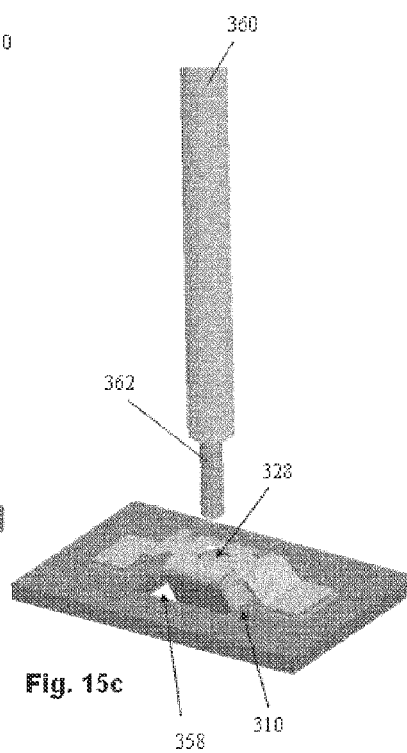
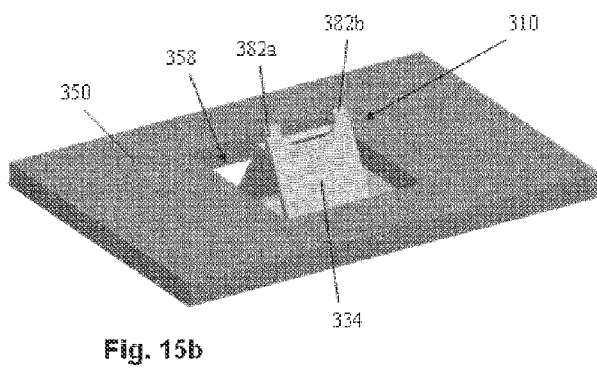
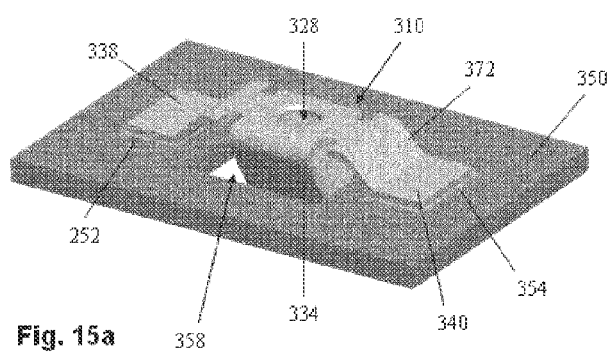


Fig. 14



SINGLE ELEMENT WIRE TO BOARD CONNECTOR

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 14/312,505, filed Jun. 23, 2014, which is a continuation of U.S. patent application Ser. No. 13/927,231, filed Jun. 26, 2013, which is a continuation-in-part of U.S. patent application Ser. No. 13/666,427, filed Nov. 1, 2012, now U.S. Pat. No. 8,721,376, issued May 13, 2014, which are incorporated herein by reference in their entirety.

FIELD

The present application relates generally to the field of electrical connectors, and more particularly to a type of connector used to connect an insulated wire to a component, such as a printed circuit board (PCB).

BACKGROUND

Various types of connectors are used for forming connections between an insulated wire and any manner of electronic component. These connectors are typically available as sockets, plugs, and shrouded headers in a vast range of sizes, pitches, and plating options. Many of these conventional connectors are referred to as Insulation Displacement Connectors (IDC) in that they include one or more contact elements incorporating a set of blades or jaws that cut through the insulation around the wire and make electrical contact with the conductive core in a one-step process, thus eliminating the need for wire stripping and crimping, or other wire preparation. IDC's are used extensively in the telecommunications industry, and are becoming more widely used in printed circuit board (PCB) applications.

Various attempts have been made to configure IDC's for surface mounting technology (SMT) applications as well. For example, U.S. Pat. No. 7,320,616 describes an IDC specifically configured for SMT mounting to a PCB utilizing an insulation piercing configuration.

AVX Corporation of South Carolina, USA, offers a line of low profile IDC wire to board connectors (Series 9175-9177) that are SMT (surface mount technology) mounted to a circuit board prior to insertion of wires into contact slots with the aid of a hand tool. This process cuts the wire insulation and enables the conductive wire cores to form a secure conductive joint with the connector.

IDC wire to board connectors are, however, not suited for all applications wherein it is desired to connect one or more wires to a component. For example, the IDC's in the above cited references are relatively complicated in that they require multiple parts that are movable relative to each other. A main insulative body is a separate component from the contact element and all or a portion of the main body must be movable or slidable relative to the contacts to make final connection with the wires after ends of the contacts have been inserted into through holes in the PCB or surface mounted to the PCB. The main insulative body of conventional IDC's can also take up valuable space (real estate) on the PCB. In this regard, IDC's are relatively complex, large, and can be cost prohibitive in certain applications.

In an embodiment, the present application provides an alternative to IDC wire to board connectors that is rugged, reliable, and simple in design.

SUMMARY

In accordance with an embodiment, an electrical connector is provided that is particularly well suited for connecting at least one insulated conductive core wire to an electrical component, such as a PCB. It should be appreciated that connectors according to the embodiment are not limited to use with boards, but may be used in any application wherein a secure electrical connection is desired between wires and any other type of component. The connectors will be described herein as used to connect wires to PCB's for illustrative purposes only.

In accordance with an embodiment, the connector is a "single element" connector in that it is formed from a single conductive contact member and does not include an insulative body or molding. The connector may be suited for a pick-and-place mounting process wherein a vacuum transfer device places the connector for subsequent surface mounting to a PCB, as is understood by those skilled in the art. The connectors are not, however, limited to this mounting technique.

An embodiment of a single element electrical connector includes a single conductive contact element formed into a cage structure, with this cage structure defining a wire insert end and a wire contact end arranged along a longitudinal centerline axis of the connector. The cage structure includes a wall structure at the insert end that defines an inlet opening for a wire at the insert end. For example, in one embodiment, the wall structure may include a plurality of walls formed into a box-like structure at the insert end, with one of the walls defining an upper pick-up surface having a surface area suitable for placement of a suction nozzle of a vacuum transfer device. The cage structure further includes a pair of contact tines biased towards the centerline axis of the connector downstream of the wall structure at the insert end in an insertion direction of the wire into the connector, with the contact tines defining a contact pinch point for an exposed core of the wire. A component of the cage structure defines a contact surface for electrical mating contact with a respective contact element or pad on the component to which the connector is mounted, such as a PCB.

In an embodiment, the connector is formed from a single stamped metal sheet bent or otherwise formed into the cage structure. Any number and configuration of cuts, reliefs, and the like, may be formed in the metal sheet to facilitate bending or otherwise shaping the metal sheet into the cage structure having the features described herein.

As mentioned, in an embodiment, the cage structure includes a plurality of walls bent into a box-like structure having a top wall, bottom wall, and side walls at the insert end of the connector, with the top wall defining the pick-up surface. In this embodiment, the top wall may be a bent-over extension of one of the side walls that extends to the opposite side wall.

The top and bottom walls may be generally parallel in one embodiment, with one or both of the top and bottom walls including a forward portion that is angled towards the centerline axis of the connector to define an upper wire guide (top wall) and/or lower wire guide (bottom wall).

The contact tines may be variously configured by the cage structure. In an embodiment, the contact tines are forward portions of the side walls that are angled towards the centerline axis at the wire contact end of the connector. The tines may include release tabs extending from a forward-most portion of the contact tines, with the release tabs configured for engagement by a tool to separate the contact

tines in order to remove a wire inserted into the connector. The release tabs may extend generally parallel to the centerline axis.

In another embodiment, the cage structure may include an end wire stop wall defined forward of the contact tines in an insertion direction of a wire into the connector, with this wall defining the ultimate end position of the conductive core of the wire in the connector. The stop wall may be variously configured by the cage structure. For example, in one embodiment, the bottom wall may extend below the contact tines, with the stop wall defined by a forward portion of the bottom wall that is bent upwards towards the centerline axis.

As mentioned, the connector is not limited by its mounting technique to a PCB or other component. In one embodiment, the contact surface is defined by a portion of the bottom wall of the cage structure such that the connector is surface mountable to a contact pad on a PCB with the centerline axis generally parallel to the PCB. In another embodiment, the connector may be intended for a through-board or top mount configuration wherein the connector extends generally perpendicular to the PCB. In this configuration, the contact surface may be defined by contact feet extending generally transversely from the walls (bottom, top, or side walls).

The present application also encompasses any manner of electrical component assembly that incorporates the unique connector element introduced above and described in detail below to electrically connect one or more wires to an electrical component. For example, the component assembly may include a PCB in electrical mating contact with one or more conductive wires via the electrical connector.

Particular embodiments of the unique insulation displacement connectors are described in greater detail below by reference to the examples illustrated in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts a perspective view of a connector in accordance with an illustrative embodiment.

FIG. 2 depicts a side cut-away view showing the connector of FIG. 1 in accordance with an illustrative embodiment.

FIG. 3 depicts a perspective top and insert end view of a connector in accordance with an illustrative embodiment.

FIG. 4 depicts a perspective side view of the connector of FIG. 3 in accordance with an illustrative embodiment.

FIG. 5 depicts a top view of the connector of FIG. 3 in accordance with an illustrative embodiment.

FIG. 6 depicts a side view of the connector of FIG. 3 in accordance with an illustrative embodiment.

FIG. 7 depicts an end view of the connector of FIG. 3 in accordance with an illustrative embodiment.

FIG. 8 depicts a perspective view of an alternative connector in accordance with an illustrative embodiment.

FIG. 9 depicts an electrical connector in accordance with an illustrative embodiment.

FIGS. 10a-10c depict a rear mounting configuration for an electrical connector in accordance with an illustrative embodiment.

FIGS. 11a-11c depict a thru-board mounting configuration for an electrical connector in accordance with an illustrative embodiment.

FIG. 12 depicts an electrical connector in accordance with an illustrative embodiment.

FIGS. 13a-13c depict a top mounting configuration for an electrical connector in accordance with an illustrative embodiment.

FIG. 14 depicts an electrical connector in accordance with another illustrative embodiment.

FIGS. 15a-15c depict a thru-board mounting configuration for an electrical connector in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

Reference will now be made to various embodiments, one or more examples of which are illustrated in the figures. The embodiments are provided by way of explanation of the invention, and are not meant as a limitation of the invention. For example, features illustrated or described as part of one embodiment may be used with another embodiment to yield still a further embodiment. It is intended that the present application encompass these and other modifications and variations as come within the scope and spirit of the invention.

Exemplary embodiments of an electrical connector 10 according to various embodiments are illustrated in FIGS. 1 through 8. The electrical connector 10 is configured for connecting the conductive core of an insulated wire to any manner of electrical component, such as a printed circuit board (PCB). For ease of explanation and illustration, the electrical connector 10 is illustrated and referred to herein in the context of connecting wires to a PCB. In addition, the electrical connector 10 is depicted in the figures as a "single-way" connector in that it includes only a single wire position. It should be appreciated that the electrical connector 10 is not limited by the number of wire positions, and multi-way embodiments are contemplated within the scope and spirit of the invention. For example, in alternative embodiments, the cage structure may be formed into a two-way or a three-way connector in addition to the illustrated single-way connector.

Referring to the figures in general, the electrical connector 10 is depicted as a single element electrical connector in accordance with various illustrative embodiments. The electrical connector 10 is particularly suited for connecting a wire 12 to any manner of electrical component, such as a PCB. The wire 12 may be a stranded or solid core wire having a core 14 surrounded by an insulation material 16. Prior to insertion of the wire 12 into the electrical connector 10, a section of the insulation material 16 is stripped away from the core 14 adjacent to the end of the wire 12, as depicted in FIGS. 1 and 2.

As mentioned above, the electrical connector 10 is a "single element" connector in that it is formed from a single conductive element 18. The single conductive element 18 may be any suitable conductive metal material having a gauge and other physical characteristics suitable for maintaining the shape of the electrical connector 10 in the mounting process, as well as in the operating environment of the electrical component to which the electrical connector 10 is mounted.

The single conductive element 18 is formed into a cage-like structure 20 as depicted in FIG. 1. In an embodiment, the single conductive element 18 is formed by bending a single piece of conductive material into the cage-like structure 20. The cage-like structure 20 includes a wire insert end 22 that defines an inlet opening 28 for insertion of the wire 12 into the electrical connector 10. The cage-like structure 20 also defines a wire contact end 24 (FIG. 1), which is the end of the cage-like structure 20 at which the exposed conductive core 14 of the wire 12 is contacted by the single conductive element 18. The wire insert end 22 and wire

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contact end **24** are aligned along a central longitudinal axis **26** of the electrical connector **10**, as depicted in FIGS. **1** and **2**.

In an embodiment, the cage-like structure **20** includes a wall structure **30** that essentially surrounds the wire **12**. The wall structure **30** may include any number and configuration of walls, such as a circular wall, semicircular wall components, and so forth. At least a portion of the wall structure **30** defines a pick-up surface **32**. The pick-up surface **32** has a surface area that is suitable for placement of a suction nozzle of a vacuum transfer device so that the electrical connector **10** may be transferred to an electrical component, such as a PCB, in a conventional pick-and-place process, as is understood by those skilled in the art. In a desirable embodiment, the electrical connector **10** is supplied in tape form that is fed to a conventional vacuum transfer device in the pick-and-place process.

The cage-like structure **20** includes a pair of contact tines **34** that are biased towards the central longitudinal axis **26** of the electrical connector **10** downstream of the wall structure **30** in the insertion direction of the wire **12** into the electrical connector **10**. These contact tines **34** are defined by sections or cutouts of the single conductive element **18** and define a contact pinch point **36** (FIG. **3**) for contact against the exposed core **14** of the wire **12**. The contact pinch point **36** also serves as a clamp point to prevent inadvertent removal of the wire **12** from the electrical connector **10**.

The electrical connector **10** includes a contact surface **38** that may be defined by any member or section of the cage-like structure **20**. The contact surface **38** is provided for electrical mating contact with a respective contact element on the electronic component. For example, the contact surface **38** may be defined by any section of the bottom portion or wall of the cage-like structure **30** that mates with a corresponding contact pad on the PCB, wherein the electrical connector **10** may be surface mounted directly onto the contact pad of the PCB.

In an embodiment, the electrical connector **10** and the single conductive element **18** are formed from a single electrically-conductive sheet material that is bent or otherwise formed into the cage-like structure **20**. Any manner of cuts, reliefs, or other structures may be cut or stamped into the single conductive element **18** to facilitate forming the single conductive element **18** into the overall configuration of the electrical connector **10** as described herein.

In an embodiment, the wall structure **30** includes a plurality of walls that are bent into a box-like structure **40** having a top wall **42**, bottom wall **44**, and opposite side walls **46**. The top wall **42** defines the pick-up surface **32** discussed above. It should also be appreciated that any one of the other walls may also define the pick-up surface **32**. The box-like structure **40** may be defined by the walls in various ways. For example, in an embodiment, the side walls **46** are components that are bent upwardly relative to the bottom wall **44**, while the top wall **42** is defined by an extension of one of the side walls **46** that is bent towards the opposite side wall **46**.

Certain embodiments of the electrical connector **10** may also include guide surfaces within the cage-like structure **20** that serve to physically contact and align the wire **12** within the cage-like structure **20**. In an embodiment, for example, an upper wire guide **48** is defined by an angled portion of the top wall **42**. This upper wire guide **48** is angled from the generally parallel top wall (parallel to the bottom wall **44**) towards the center longitudinal (or centerline) axis **26**, as illustrated in FIGS. **2** and **3**. Similarly, the bottom wall **44**, which may be parallel to the top wall **42**, may have a forward

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portion that is angled towards the center longitudinal axis **26** to define a lower wire guide **50**, as illustrated in FIGS. **2**, **6**, and **7**.

As mentioned, the contact tines **34** may be variously configured within the cage-like structure **20**. In the illustrated embodiment, the contact tines **34** are defined by forward portions of each of the side walls **46** that are bent or angled towards the center longitudinal axis **26** to the pinch point **36**. In this manner, the contact tines **34** are biased towards each other (and the center longitudinal axis **26**). The contact tines **34** separate and engage against the core **14** of the wire as the wire inserted through the contact tines **34**.

In various embodiments, e.g., FIGS. **3** and **5**, it may be desired to include one or more release tabs **52** defined on each of the contact tines **34** generally forward of the pinch point **36**. The release tabs **52** provide a location for insertion of a tool between the contact tines **34** in order to open the contact tines **34** for removal of the wire **12** if desired. The release tabs **52** may be variously configured. In the illustrated embodiment, the release tabs **52** include generally forwardly extending tabs that are substantially parallel to the center longitudinal axis **26** with the wire **12** removed from the electrical connector **10**, as depicted in FIG. **5**.

In various embodiments, it may also be desired to include a wire stop wall **54** relative to the wire contact end **24** of the cage-like structure **20**. The wire stop wall **54** provides a surface against which the conductive core **14** of the wire **12** may abut in the completely inserted position of the wire **12**, as depicted in FIG. **2**. The wire stop wall **54** may be variously configured. In an embodiment, the wire stop wall **54** is formed from a bent-up portion of the bottom wall **44**. The wire stop wall **54** may further include an overhang or lip **58** that extends back towards the pinch point **36** of the contact tines **34**. This overhang or lip **58** may serve to prevent inadvertent removal of the wire **12** in a vertical direction relative to the electrical connector **10**.

As mentioned, the contact surface **38** may be defined by any portion of the bottom wall **44** (or any other wall) that aligns with a mating contact pad on a PCB. According to such an embodiment, the electrical connector **10** may be configured for conventional surface mount processes.

In an alternative embodiment depicted in FIG. **8**, the electrical connector **10** may be configured for a thru-board connection wherein the connector extends through a hole in a PCB. Contact feet **56** are provided for mating against a contact pad on either side of the thru-hole in the PCB. Similarly, the contact feet **56** may serve for surface mounting of the electrical connector **10** on a PCB wherein the electrical connector **10** assumes a relatively vertical (i.e., perpendicular) orientation relative to the PCB. In the embodiment depicted in FIG. **8**, the contact feet **56** are defined by outwardly bent portions of each side wall **46**. In an alternative embodiment, the contact feet **56** may also be defined by outwardly bent portions of the bottom wall **44** and top wall **42**.

FIG. **9** depicts an electrical connector **110** in accordance with an illustrative embodiment. In an embodiment, the electrical connector **110** is a "single element" connector in that it is formed from a single conductive element. The single conductive element may be any suitable conductive metal material having a gauge and other physical characteristics suitable for maintaining the shape of the electrical connector **110** in the mounting process, as well as in the operating environment of the electrical component to which the electrical connector **110** is mounted. In an embodiment, the electrical connector **110** does not have an insulating component.

The electrical connector **110** includes an opening **128** that is configured to receive a wire or other electrically-conductive component inserted into the electrical connector **110**. The electrical connector **110** includes a pair of contact tines **134**. The pair of contact tines **134** are biased toward a central longitudinal axis of the electrical connector **110** downstream of the opening **128** in an insertion direction of a wire or other electrically-conductive component into the electrical connector **110**. The contact tines **134** may be formed from portions of the single conductive element that are bent or angled toward the central longitudinal axis to form a pinch point **136**. The contact tines **134** are configured to contact an exposed core or portion of a wire or other electrically-conductive component inserted into the electrical connector **110**. The contact tines **134** may be configured to separate and engage against the core of the wire or other electrically-conductive component as the wire or other electrically-conductive component is inserted between the contact tines **134**. In this way, the contact pinch point **136** may also perform a clamping mechanism to prevent inadvertent removal of the wire or other electrically-conductive component from the electrical connector **110**. In various embodiments, it may be desirable to include one or more release tabs defined on each of the contact tines **134** to provide a location for insertion of a tool between the contact tines **134** in order to open the contact tines **134** for selective removal of the wire or other electrically-conductive component.

In various alternative embodiments, electrical connector **110** may include one or more additional contact tines **134**. The contact tines **134** may be formed from sections or cutouts of the single conductive element.

In addition, one or more of contact tines **134** may include one or more release tabs **182a**, **182b**. In an embodiment, release tabs **182a**, **182b** are defined on one or more of the contact tines **134** generally forward of the pinch point **136**. For example, the release tabs **182a**, **182b** may include extensions of a main body of the contact tines **134**. The release tabs **182a**, **182b** provide a location for insertion of a tool between the contact tines **134** in order to open the contact tines **134** for removal of a wire if desired. The release tabs **182a**, **182b** may be variously configured. In the illustrated embodiment, the release tabs **182a**, **182b** include generally forwardly extending tabs that are substantially parallel to a center longitudinal axis that extends through the opening **128**.

The electrical connector **110** also includes contact surfaces **138** and **140** that may be defined by any member or section of the single conductive material. The contact surfaces **138** and **140** are configured to electrically couple to respective contact elements on an electrical component such as a PCB or other electrical device. In an embodiment, the electrical connector **110** may be surface mounted directly onto the contact pad of the PCB or other electrical device.

FIG. **10a** depicts a bottom view of a rear mounting configuration for the electrical connector **110** in accordance with an illustrative embodiment. In an embodiment, the electrical connector **110** is mounted to a surface of a PCB **150**. The electrical connector **110** includes the contact surfaces **138** and **140** which are electrically coupled to contact pads **152** and **154**, respectively, of the PCB **150**.

FIG. **10b** depicts a top view of the rear mounting configuration for the electrical connector **110** in accordance with an illustrative embodiment. As mentioned above, the electrical connector **110** is mounted to a surface of the PCB **150**. The PCB **150** includes an opening **158** that is configured to receive a wire or other electrically-conductive component to be inserted into the electrical connector **110**.

FIG. **10c** depicts another bottom view of the rear mounting configuration for the electrical connector **110** in accordance with an illustrative embodiment. A wire **160** includes an exposed conductive core **162**. As discussed above, the PCB **150** includes the opening **158** which is configured to receive the exposed conductive core **162**. The exposed conductive core **162** of the wire **160** may thus be inserted through the opening **158** of the PCB **150** into the electrical connector **110** such that the exposed conductive core **162** may be seated between the contact tines **134** of the electrical connector **110**, thereby forming an electrical connection between the wire **160**, the electrical connector **110**, and the contact pads **152** and **154**.

FIG. **11a** depicts a top view of a thru-board mounting configuration for the electrical connector **110** in accordance with an illustrative embodiment. In an embodiment, the electrical connector **110** is secured to a first surface of the PCB **150** and extends through the opening **158** in the PCB **150**. The electrical connector **110** includes the contact surfaces **138** and **140** which are electrically coupled to contact pads **152** and **154**, respectively, on the first surface of the PCB **150**. The contact tines **134** of the electrical connector **110** extend thru the opening **158** in the PCB **150** such that the contact tines **134** extend outward a distance from a second surface of the PCB **150** that is opposite the first surface.

FIG. **11b** depicts a bottom view of the thru-board mounting configuration for the electrical connector **110** in accordance with an illustrative embodiment. As mentioned above, the electrical connector **110** is mounted to a first surface of the PCB **150**. The PCB **150** includes the opening **158** through which the contact tines **134** extend.

FIG. **11c** depicts another top view of the thru-board mounting configuration for the electrical connector **110** in accordance with an illustrative embodiment. The wire **160** includes the exposed conductive core **162**. As discussed above, the electrical connector includes the opening **128** which is configured to receive the exposed conductive core **162** of the wire **160**. The exposed conductive core **162** of the wire **160** may thus be inserted through the opening **128** of the electrical connector **110**. In turn, the exposed conductive core **162** is inserted between the contact tines **134** and through the opening **158** in the PCB **150** such that the exposed conductive core **162** may be seated between the contact tines **134** of the electrical connector **110**. In this way, upon fully seating the wire **160** within the electrical connector **110**, the wire **160** will extend through the opening **158** in the PCB **150**.

FIG. **12** depicts an electrical connector **210** in accordance with an illustrative embodiment. In an embodiment, the electrical connector **210** is a "single element" connector in that it is formed from a single conductive element as discussed in additional detail above. The single conductive element may be any suitable conductive metal material having a gauge and other physical characteristics suitable for maintaining the shape of the electrical connector **210** in the mounting process, as well as in the operating environment of the electrical component to which the electrical connector **210** is mounted.

The electrical connector **210** includes contact surfaces **238** and **240** that may be defined by any member or section of the single conductive material. The contact surfaces **238** and **240** are configured to electrically couple to respective contact elements on an electrical component such as a PCB or other electrical device. In an embodiment, the electrical connector **210** may be surface mounted directly onto the contact pad of the PCB or other electrical device. The

contact surfaces **238** and **240** are connected to a main body portion of the electrical connector **210** by raised portions **270** and **272**, respectively. Raised portions **270** and **272** extend away from contact surfaces **238** and **240**, respectively, at an angle such that a main body portion of the electrical connector **210** which includes an opening **228** is located at a different height from a mounting surface relative to the contact surfaces **238** and **240**. Such embodiments allow the electrical connector **210** to be mounted to either side of a PCB. For example, the electrical connector **210** may be top mounted or rear mounted, thereby providing the option of connecting a wire from either side of the PCB and not restricting on which side of the PCB additional circuitry may be located.

The opening **228** is configured to receive a wire or other electrically-conductive component inserted into the electrical connector **210**. The electrical connector **210** includes a pair of contact tines **234** that extend from a surface in which the opening **228** is formed in a direction away from contact surfaces **238** and **240**. In various alternative embodiments, electrical connector **210** may include one or more additional tines **234**. The contact tines **234** may be formed from sections or cutouts of the single conductive element. The contact tines **234** are biased towards a central longitudinal axis of the electrical connector **210** downstream of the opening **228** in the insertion direction of a wire or other electrically-conductive component into the electrical connector **210**. For example, the contact tines **234** may be formed from portions of the single conductive element that are bent or angled towards the central longitudinal axis to form a pinch point **236**. The contact tines **234** are configured to contact an exposed core or portion of a wire or other electrically-conductive component inserted into the electrical connector **210**. The contact tines **234** may be configured to separate and engage against the core of the wire or other electrically-conductive component as the wire or other electrically-conductive component is inserted between the contact tines **234**. In this way, the pinch point **236** may also serve as a clamp point to prevent inadvertent removal of the wire or other electrically-conductive component from the electrical connector **210**. In various embodiments, it may be desirable to include one or more release tabs defined on each of the contact tines **234** to provide a location for insertion of a tool between the contact tines **234** in order to open the contact tines **234** for selective removal of the wire or other electrically-conductive component.

In addition, one or more contact tines **234** may include one or more release tabs **282a**, **282b**. In an embodiment, release tabs **282a**, **282b** are defined on one or more of the contact tines **234** generally forward of the pinch point **236**. For example, the release tabs **282a**, **282b** may include extensions of a main body of the contact tines **234**. The release tabs **282a**, **282b** provide a location for insertion of a tool between the contact tines **234** in order to open the contact tines **234** for removal of a wire if desired. The release tabs **282a**, **282b** may be variously configured. In the illustrated embodiment, the release tabs **282a**, **282b** include generally forwardly extending tabs that are substantially parallel to a center longitudinal axis that extends through the opening **228**.

FIG. **13a** depicts a bottom view of a top mounting configuration for the electrical connector **210** in accordance with an illustrative embodiment. In an embodiment, the electrical connector **210** is mounted to a surface of a PCB **250**. The electrical connector **210** includes the contact surfaces **238** and **240** which are electrically coupled to contacts pads **252** and **254**, respectively, of the PCB **250**.

The raised portions **270** and **272** extend away from the contact surfaces **238** and **240**, respectively, at an angle such that portion of the electrical connector **210** in which the opening **228** is formed is located at an increased distance from a surface of the PCB **250**.

FIG. **13b** depicts a top view of the top mounting configuration for the electrical connector **210** in accordance with an illustrative embodiment. As mentioned above, the electrical connector **210** is mounted to a surface of the PCB **250**. The PCB **250** includes an opening **258** that is configured to receive a wire or other electrically-conductive component to be inserted into the electrical connector **210**. FIG. **13c** depicts another bottom view of the top mounting configuration for the electrical connector **210** in accordance with an illustrative embodiment. A wire **260** includes an exposed conductive core **262**. As discussed above, the PCB **250** includes the opening **258** which is configured to receive the exposed conductive core **262**. The exposed conductive core **262** of the wire **260** may thus be inserted through the opening **258** of the PCB **250** into the electrical connector **210** such that the exposed conductive core **262** may be seated between the contact tines **234** of the electrical connector **210**.

FIG. **14** depicts an electrical connector **310** in accordance with an illustrative embodiment. In an embodiment, the electrical connector **310** is a "single element" connector in that it is formed from a single conductive element as discussed in additional detail above. The electrical connector **310** includes contact surfaces **338** and **340** that may be defined by any member or section of the single conductive material. The contact surfaces **338** and **340** are configured to electrically couple to respective contact elements on an electrical component such as a PCB or other electrical device. In an embodiment, the electrical connector **310** may be surface mounted directly onto the contact pad of the PCB or other electrical device. The contact surfaces **338** and **340** are connected to a main body portion of the electrical connector **310** by raised portions **370** and **372**, respectively. Raised portions **370** and **372** extend away from contact surfaces **338** and **340**, respectively, at an angle such that a main body portion of the electrical connector **310** which includes an opening **328** is located at a different height from a mounting surface relative to the contact surfaces **338** and **340**. Once again, such embodiments allow the electrical connector **310** to be mounted to either side of a PCB. For example, the electrical connector **310** may be top mounted or rear mounted, thereby providing the option of connecting a wire from either side of the PCB and not restricting on which side of the PCB additional circuitry may be located.

The opening **328** is configured to receive a wire or other electrically-conductive component inserted into the electrical connector **310**. The electrical connector **310** includes a pair of contact tines **334** that extend from the surface in which the opening **328** is formed in a direction back toward the contact surfaces **338** and **340**. In various alternative embodiments, electrical connector **310** may include one or more additional tines **334**. The contact tines **334** may be formed from sections or cutouts of the single conductive element. The contact tines **334** are biased towards a central longitudinal axis of the electrical connector **310** downstream of the opening **328** in the insertion direction of a wire or other electrically-conductive component into the electrical connector **310**. For example, the contact tines **334** may be formed from portions of the single conductive element that are bent or angled towards the central longitudinal axis to form a pinch point **336**. The contact tines **334** are configured to contact an exposed core or portion of a wire or other

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electrically-conductive component inserted into the electrical connector 310. The contact tines 334 may be configured to separate and engage against the core of the wire or other electrically-conductive component as the wire or other electrically-conductive component is inserted between the contact tines 334. In this way, the pinch point 336 may also serve as a clamp point to prevent inadvertent removal of the wire or other electrically-conductive component from the electrical connector 310. In various embodiments, it may be desirable to include one or more release tabs defined on each of the contact tines 334 to provide a location for insertion of a tool between the contact tines 334 in order to open the contact tines 334 for selective removal of the wire or other electrically-conductive component.

In addition, one or more of contact tines 334 may include one or more release tabs 382a, 382b. In an embodiment, release tabs 382a, 382b are defined on one or more of the contact tines 334 generally forward of the pinch point 336. For example, the release tabs 382a, 382b may include extensions of a main body of the contact tines 334. The release tabs 382a, 382b provide a location for insertion of a tool between the contact tines 334 in order to open the contact tines 334 for removal of a wire if desired. The release tabs 382a, 382b may be variously configured. In the illustrated embodiment, the release tabs 382a, 382b include generally forwardly extending tabs that are substantially parallel to a center longitudinal axis that extends through the opening 328.

FIG. 15a depicts a top view of a thru-board mounting configuration for the electrical connector 310 in accordance with an illustrative embodiment. In an embodiment, the electrical connector 310 is secured to a first surface of the PCB 350 and extends through the opening 358 in the PCB 350. The electrical connector 310 includes the contact surfaces 338 and 340 which are electrically coupled to the contacts pads 352 and 354, respectively, on the first surface of the PCB 350. The contact tines 334 of the electrical connector 310 extend thru the opening 358 in the PCB 350 such that the contact tines 334 extend a distance above a second surface of the PCB 350 that is opposite the first surface.

FIG. 15b depicts a bottom view of the thru-board mounting configuration for the electrical connector 310 in accordance with an illustrative embodiment. As mentioned above, the electrical connector 310 is mounted to a first surface of the PCB 350. The PCB 350 includes the opening 358 through which the contact tines 334 extend. FIG. 15c depicts another top view of the thru-board mounting configuration for the electrical connector 310 in accordance with an illustrative embodiment. The wire 360 includes the exposed conductive core 362. As discussed above, the electrical connector includes the opening 328 which is configured to receive the exposed conductive core 362 of the wire 360. The exposed conductive core 362 of the wire 360 may thus be inserted through the opening 328 of the electrical connector 310. In turn, the exposed conductive core 362 is inserted between the contact tines 334 and through the opening 358 in the PCB 350 such that the exposed conductive core 362 may be seated between the contact tines 334 of the electrical connector 310. In this way, upon fully seating the wire 360 within the electrical connector 310, the wire 360 will extend through the opening 358 in the PCB 350.

It should be readily appreciated by those skilled in the art that various modifications and variations can be made to the embodiments of the invention illustrated and described herein without departing from the scope and spirit of the

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invention. It is intended that such modifications and variations be encompassed by the appended claims.

What is claimed is:

1. An electrical connector comprising:

a single conductive contact element defining a cage structure, wherein the single conductive contact element comprises:

an insert end having an inlet opening for receipt of a wire;

a contact end, wherein the insert end and the contact end are positioned along a longitudinal centerline axis of the cage structure; and

a first contact tine extending from a first wall of the cage structure and defining a contact pinch point at the contact end, wherein the first contact tine is biased toward the centerline axis of the cage structure in an insertion direction of the wire into the cage structure;

a wire guide extending from a second wall of the cage structure that is substantially perpendicular to the first wall of the cage structure, wherein the wire guide is angled toward the centerline axis of the cage structure and extends only a portion of a distance along the insertion direction between the second wall of the cage structure and the contact pinch point; and a contact surface defined by at least one of the second wall or a third wall of the cage structure, wherein the contact surface is configured for electrical connection with a respective contact element on an opposing electrical component.

2. The electrical connector of claim 1, wherein the single conductive contact element consists of a single piece of electrically-conductive material.

3. The electrical connector of claim 1, wherein the electrical connector does not include an insulator.

4. The electrical connector of claim 1, wherein the single conductive contact element further comprises a second contact tine.

5. The electrical connector of claim 4, wherein the first contact tine comprises a first release tab extending therefrom and the second contact tine comprises a second release tab extending therefrom, wherein the first and second release tabs comprise extensions from a main body portion of the respective first and second contact tines, and wherein the first and second release tabs extend less than an entire distance across a forward-most portion of the respective first and second contact tines.

6. The electrical connector of claim 5, wherein the first and second release tabs extend in a direction of a centerline axis of the contact element.

7. The electrical connector of claim 5, wherein the first release tab is on a first side of the first contact tine, and wherein the second release tab is on a same side of the second contact tine.

8. The electrical connector of claim 5, wherein the first and second release tabs extend generally parallel to the centerline axis.

9. The electrical connector of claim 5, wherein the first and second release tabs extend from the forward-most portion of the first and second contact tines, respectively, in the insertion direction.

10. The electrical connector of claim 4, wherein the at least one of the first or second contact tines comprises a bent-over extension of a side of the cage structure.

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11. The electrical connector of claim 4, wherein the first and second contact tines are angled towards the centerline axis to define a space that guides an inserted wire to the contact pinch point.

12. The electrical connector of claim 4, wherein the contact surface includes contact feet extending generally transversely from the cage structure at the insert end such that, upon mounting of the electrical connector to a component, the centerline axis is generally perpendicular to the component.

13. The electrical connector of claim 1, wherein the first contact tine extends from the cage structure in a direction back toward the contact surface and away from the insert end.

14. An electrical device comprising:

a single conductive contact element defining a cage structure, wherein the single conductive contact element comprises:

a contact surface;

an insert end having an inlet opening for receipt of a wire;

a contact end, wherein the insert end and the contact end are positioned along a longitudinal centerline axis of the cage structure; and

a first contact tine extending from a first wall of the cage structure and defining a contact pinch point at the contact end, wherein the first contact tine is biased toward the centerline axis of the cage structure in an insertion direction of the wire into the cage structure; and

a wire guide extending from a second wall of the cage structure that is substantially perpendicular to the first wall of the cage structure, wherein the wire guide is angled toward the centerline axis of the cage structure and extends only a portion of a distance along the insertion direction between the second wall of the cage structure and the contact pinch point; and

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a printed circuit board comprising a contact pad, wherein the contact pad is electrically connected to the contact surface.

15. The electrical device of claim 14, wherein the printed circuit board comprises an opening that corresponds to the inlet opening of the contact element such that the centerline axis of the contact element runs through the opening of the printed circuit board.

16. The electrical device of claim 15, further comprising a wire extending through the opening in the printed circuit board and through the inlet opening of the contact element, wherein the wire is electrically connected to the contact element via the first contact tine.

17. The electrical device of claim 16, wherein the contact surface includes contact feet extending generally transversely from the cage structure at the insert end such that, upon mounting of the electrical connector to the printed circuit board, the centerline axis is generally perpendicular to the printed circuit board.

18. The electrical device of claim 14, wherein the contact element consists of a single piece of electrically-conductive material.

19. The electrical device of claim 14, wherein the contact element further comprises a second contact tine, and wherein the first contact tine comprises a first release tab extending therefrom and the second contact tine comprises a second release tab extending therefrom, wherein the first and second release tabs comprise extensions from a main body portion of the respective first and second contact tines, and wherein the first and second release tabs extend less than an entire distance across a forward-most portion of the respective first and second contact tines.

20. The electrical device of claim 14, wherein the contact element does not include an insulator.

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